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Home College Series.

Number ~~~~~ ❋ ~~~~~ *Forty-Two.*

METEORS.

BY

REV. C. M. WESTLAKE, M.S.

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SEP 20 1883
No. 16815-0
CITY OF WASHINGTON

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PHILLIPS & HUNT.
CINCINNATI:
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J. H. Vincent.

New York, *Jan.*, 1883.

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METEORS.

Meteors, Meteorites, and Comets evidently sustain some sort of relation to the solar system; but whether that of constituent members, or only as strange, and by no means necessary, visitors, it is exceedingly difficult to determine. These three classes of bodies are separate and distinct from the larger aggregations of matter called planets, but are, nevertheless, composed of some similar elements, subject measurably to the same laws and form, and integral of the same universe. They correspond somewhat with each other in their periods of greatest and least abundance, revolution about the sun, and meeting of the earth in its orbital motion. Hence they frequently observe a similar order of grouping, and may be found together in a common stream reaching over millions of miles through space. They differ in magnitude, as also in density. While some of the meteors are minute atoms which, in contact with our atmosphere, are dissipated by the heat of the collision into a cloud of dust or smoke, certain of the meteorites, and fragments of others, as small and diminished bodies of solid rock or metallic substance, reach the earth, after great loss from friction in passing through the atmosphere. Comets are of much greater magnitude—possibly the source of these other bodies—and some of them have known periodic appearances numbered by centuries.

Comets, meteors, and meteorites are among the most startling and wonder-creating phenomena of our solar system. Comets—vast extents of rarest gas of ghostly luminosity—will be specially considered in a future paper. Meteorites—also in main reserved for a separate discussion—as bodies more dense than either of the others, approach more

nearly to the earth's surface, and, indeed, in some instances, strike it with terrific force; while, more frequently, after a violent explosion they cast fragments down upon the earth and then sweep away into space beyond.

GENERAL CHARACTERISTICS OF METEORS.

In density and constituent elements meteors more closely resemble comets; but in dimensions and proximity to the earth they are more like meteorites. Possibly meteors are the least important, yet they are by all odds the most numerous of all these bodies. They are commonly called "shooting-stars," and have been likened to "fiery arrows shot from some invisible bow in space" as they dart across the sky and disappear, leaving in their wake, only for a few moments, feathery lines of light and a film of smoky vapor. They appear in all parts of the heavens, and dart in all possible directions; but by far the greater number are seen shooting obliquely toward the earth from east to west. Occasionally, from some unknown cause, they have been seen to dart upward. Their general line of motion, however, is toward the earth; but they never reach it, and do not even come very near it, as is conclusively proven by the fact that they are never seen during a cloudy day. *Meteorites* appear *beneath* the clouds, but *meteors* never do. The clouds vary from one fifth of a mile to five miles in height, while the altitude of visible meteors ranges anywhere from six to 140 miles. The suddenness of their appearance and disappearance argues their entire consumption at a considerable height in the earth's atmosphere. Seemingly they move silently through space. At any rate they are unaccompanied by an audible report, such as is heard in the explosion of a meteorite. To this latter class belongs *the so-called meteor* reported but recently as being seen from the towns of Petersburg and Fredericksburg in Virginia. It is spoken of as "the most remarkable celestial phenomenon ever witnessed in that

vicinity." About 5 o'clock on the morning of March 4, 1883, an immense ball of fire passed across the heavens from the north-west toward the south-west. Its light was of a brilliant blue tint, and so illuminated these towns that a newspaper might have been read with ease. The spectacle was a grand one, but much alarm was created by the meteorite exploding with loud detonations followed by distinct tremors of the earth. Persons were awakened all along its route by the noise and shocks. Possibly if we were sufficiently near one of the larger *meteors* we would be even more appalled by the hissing, rushing, roaring sound of its swiftly moving and highly heated mass. Even a gaseous body, moving at the appalling speed of from 35 to 100 miles per second through a resisting medium—though it be of the slightest density—must produce some perceptible noise. And when through friction the mass bursts into flame, the volume of sound must be correspondingly increased. Of course, the larger the body the greater the noise of motion. Meteors vary greatly in size, from those invisible to the naked eye to others of the apparent size and brightness of the moon. It is quite probable some of these peculiar bodies are not more than a few feet in diameter, as they are so soon consumed. One was seen which remained visible for some time, and if, as was supposed, it was 110 miles distant, it could not have been less than one mile in diameter.

An interesting account of meteors seen in 1718 is to be found from the pen of the great astronomer, Edmund Halley, in the twenty-ninth volume of the "Transactions of the Royal Society of London." He cites one, more remarkable than others, which Sir Hans Sloane claimed to have seen while walking the streets of London. "This meteor appeared in the evening, a few minutes after eight o'clock, the sky being clear and the moon shining brightly near the meridian. Suddenly a great light appeared in the west, which he at first attributed to rockets or fire-works; but he

was soon undeceived, for, on casting his eyes toward the light, he saw a splendid meteor in the direction of the Pleiades, having a long luminous train, or tail, of a most dazzling brilliancy. It left behind it a track of a yellowish-red color, which seemed to sparkle. The splendor of this meteor was little inferior to that of the sun; and so strong was the light that, within doors, candles were of no use; and although the moon shone brightly, her light was scarcely visible. In fact, for a few seconds, the light resembled that of day." A surpassingly brilliant meteor passed over Canada and the northern part of the United States on the 18th of May, 1838. Professor Loomis estimated it to be thirty miles above the earth, three quarters of a mile in diameter, and having a velocity of about 40 miles per second.

How can even the immense velocity of meteors produce heat and flame in those higher regions of the atmosphere, where the air is so thin and the cold so very intense? is a question both pertinent and suggestive. We all know something of friction as a heat producer. The aborigines of America procured fire by briskly rubbing two pieces of wood of the proper condition one upon the other. The more combustible a substance, while proportionately capable of resisting force, the more quickly can it be set on fire by friction. The rapid motion of the meteor evidently compresses the thin air of the higher atmosphere into a sufficient density—affords some resistance, and yet it must be so slight as to fail of producing fire were this body not composed of some very light and highly inflammable substance. A reasonable supposition is, therefore, that a meteor is a gaseous, phosphorescent body, which ignites at a very low temperature.

ORIGIN OF METEORS.

Formerly the supposition obtained credence that meteors originated in gaseous exhalations from the earth, and were ignited by the oxygen of the atmosphere after the manner

of the common phenomenon called the Jack-o'-lantern, which is produced as follows: Sometimes in low, swampy ground, from decaying bones will rise phosphorus acid, and near by, from decaying leaves at the bottom of stagnant water, hydrogen gas will rise to the surface. These two gases unite, forming the compound known as phosphoretted hydrogen, which is so highly inflammable that it ignites by simple contact with the oxygen of the air, the current of which it follows until all is consumed. But meteors are not immense Jack-o'-lanterns. This is evident from the great height at which meteors are seen, as also from the magnitude of certain meteoric displays. Phosphoretted hydrogen, in such quantities as the earth produces, is insufficient for these displays, and, even if sufficient, it would be all consumed long before reaching the meteoric heights. Therefore we must look to some other source than our planet for the origin of these bodies.

Among the recent great discoveries in the science of astronomy is that of a remarkable connection between comets, meteors, and meteorites. From careful observations and calculations it is found the shape, size, and position of their orbits so exactly coincide that the suggestion is a natural and probably a true one, that comets comprehend, if they do not entirely consist of, clouds of meteors and meteorites. Hence, if we find the origin of one, we will literally find it to be the common origin of all three of these peculiar bodies. The nebular hypothesis offers an explanation of cometic origin somewhat after the following manner: Matter is said to have been motionless and thinly diffused through space until the omnipotence of God endued it with the property of attraction; then *all* the particles of matter, in every part of the material universe, were thus set in motion: bodies of various degrees of density were formed around centers of aggregation, where these particles collected in the greatest number; the more slightly condensed of these bodies are

comets. This theory has evoked a great deal of just criticism. Another and more recent one, which may be termed the solar hypothesis, is received with great favor, and in the light of certain discoveries is the more satisfactory. According to *this* theory, the sun by volcanic force expels from its interior, and with great violence throws, the matter found in comets, meteors, and meteorites far beyond the sphere of his superior attraction. Besides this *projectile* or *volcanic* force, the sun's mysterious *repelling* or *electric* force contributes more largely, perhaps, than the attraction of other systems of worlds to the forcing off of these newly formed cometary bodies into the depths of space. Probably none of these forces alone would be sufficient; but all taken together could, as a matter of fact, produce these wonderful results. Well known solar phenomena furnish sufficient ground for this theory of the comet-making power of the sun. This body experiences convulsions of the most grand and terrific character; "convulsions compared with which all the tornadoes, tempests, earthquakes, and volcanic eruptions of earth are but as the rippling waves of some embowered pool."

With the superior instruments of to-day, men have witnessed and measured, with great accuracy, the effects of these mighty and violent eruptive forces. Not only from the surface of the sun, but from its great and unknown depths, huge molten masses, gaseous, liquid, and solid, are upheaved, projected into and far beyond the solar atmosphere. These have been seen in a continuously expanding form at the astonishing height of 100,000, and even 200,000, miles. Is it not highly probable some of this same matter, so highly attenuated as to be for the time invisible to us, is projected so far into space that it does not fall back into the sun, but moves off to an inconceivably great distance, where its initial velocity being partly spent, and the repelling force being overcome by the attracting force of the sun, it sweeps

back, in a highly elliptical orbit, with ever-increasing velocity till, in its rapid curve about, when it is nearest to the sun, the repelling force again overcoming the attractive force, it again sweeps away to a great distance? If this supposition be true to fact, we might naturally expect what actually does occur, namely, an increase of cometic density with the increase of distance from the sun, and a corresponding decrease of the same on nearing the sun. While the foregoing theory may account for the existence of such comets as from their movements appear to belong to our system, we must seek a source of origin outside the solar system for such comets as drop down upon us from the infinite heights of space, and then speed away with very little probability of ever again returning. These seemingly lawless wanderers must have some such remote birthplace as the stars. That such is the case appears the more probable when we take into consideration the fact that the stars are also suns, and of a similar constitution to our own. It is but natural to suppose that they, too, are engaged in comet-forming processes, only, in the main, upon a much larger scale than our sun, since by their greater proportions they are capable of exerting a correspondingly greater expulsive and repelling force. The Dogstar (Sirius) is supposed to be 2,000 times larger in volume or bulk, while the star Vega, in the constellation of the Harp, has been estimated to be upward of 50,000 times larger than our sun. If the sun is a globe of liquid molten matter, with heaving, rolling, tossing flame-billows of the height of 10 and 20 miles, the stars must have similar billows of fire, hundreds of times greater in magnitude, momentum, and force. The action of such forces on such a stupendous scale is appalling, even in thought. Imagine these flame billows reaching the height of one and two thousand miles, rushing, surging, roaring, as they roll on around the vast fiery world, unobstructed by headlands, capes, or promontories, and with no break to their force by resisting shores. And

besides all this, as we saw upon the sun, there are here even mightier forces, manifest in those physical agitations and eruptions, projecting matter in an incredibly short time to an inconceivably great height. From this projected stellar matter, doubtless, come those comets which do not belong to, though they may, in great periods of time, visit, our solar system. Some of the greatest intellects known to the world have been occupied with this subject as one of no little interest. A common conclusion, founded upon the foregoing facts and the long period of some of the comets, is that some, at least, come from the stars.

It has been seen that the period of one was 100,000 years, and that of another 122,000 years, while others have baffled computation. It is known, however, to require 8,000,000 years for a comet from the nearest star to make this friendly visit. If the former statement be true, that comets comprehend, if they do not entirely consist of, clouds of meteors and meteorites, then it follows, as a matter of course, that some of these peculiar bodies which reach our atmosphere, as well as some of the dust and fragments which reach the earth, originally came from the stars. The reason for supposing this intimate relation of these meteors and meteorites with comets has been hinted at, and it may also be in place to give a word of additional explanation before considering certain notable instances of meteoric displays. Meteors are most frequently seen after a comet and along its path, sometimes, indeed, falling in great showers, when they are numbered by millions. The supposition is that the cometic matter of the train, partially driven off by the repelling or electric force of the sun, has been partially attracted by the earth, so that a considerable portion has been drawn off and appears in our atmosphere as meteors. It may seem strange that meteors are often seen in the absence of cometic appearances, and yet it would be unjustifiable to infer from this other than a cometary source for meteors. It does not follow that comets

do not exist where they are not seen. "Large numbers pass unnoticed, because of their distance, their dimness, and their small size; while many more enter our heavens and depart unseen during the day and moonlight nights, but leave a portion of their matter in the remote regions of space; and this matter, after some time, finds its way to our globe, and is drawn into our atmosphere and then ignited by the friction and the oxygen of the air. Thus it will be understood why meteors or shooting-stars are seen when no comets are visible."

METEORIC DISPLAYS.

Meteors sometimes shoot toward the earth in showers of thousands, with more or less brilliancy, and at times emitting sufficient light to illuminate the heavens. These phenomena occur periodically. They are often seen at other times, especially in the tropics; but the time most likely for them to be seen is about the 10th of August and the 12th and 13th of November. In Scotland, on the morning of the 14th of November, 1866, at about a quarter past 1 o'clock, a most brilliant and exceedingly striking meteoric shower was witnessed. The one of 1867 was scarcely less remarkable for the number and brilliance of the meteors. Similar phenomena have occurred about the 12th of November, 1799, in South America at Cumana; November, 1831, in Ohio and in Spain; and in the western part of Asia and the southern part of Europe in November, 1832. But the most magnificent shower of meteors which has ever been known was that which fell during the night of the 12th of November, 1833. This shower commenced about nine o'clock in the evening, and continued till the morning sun concealed them from view. This amazing exhibition extended from Canada to the northern boundary of South America, and from about longitude 61 degrees in the Atlantic to 100 degrees in the heart of Mexico. On the following night other parts of the world gazed upon a similar though less brilliant spectacle. For some years

following, meteoric showers occurred about the same time in November, yet never equaling in number, brightness, or duration that of 1833. "The heavens probably never offered, and earth surely never beheld, a spectacle so sublime." The sky seemed to be emptying itself upon the earth of all its starry bodies. To those who believed such to be the case it must have been surprising that a single sparkler was left to shine in the heavens on the succeeding night. But not a star had disappeared from the blue vault above. "The heavens" still continue "to number out the glory of the strong God," "for that he is strong in power not one faileth." During this downpour of meteors nearly every one left a luminous feathery streak along its path, which soon totally vanished from sight. Some of the larger meteors, shooting across the heavens, drew longer, broader, and brighter dashes of light, which would remain for quite a while and assume peculiar shapes, resembling different objects, according as the beholder was under the influence of fear, superstition, or imagination. Hence, fantastic lines, swords, spears, and huge serpents, as also the word "war," written in characters of fire on the dark sky, were confidently asserted to have been seen. In the north-east, however, a pruning-hook was distinctly visible for a full hour and a quarter. The Scripture gives as one of the characteristics of the last day the falling of the stars from heaven. Many thought the end of all things had arrived, and some actually died of terror, believing the heavens and the earth to be on fire, and that the day of judgment was at hand. Aside from the magnifying effect of fear and the numerous additions of imagination, it was a scene peculiarly grand and impressive, and one never to be forgotten.

UTILITY OF METEORS.

By some it is supposed that they introduce essential elements into our atmosphere, and, indeed, in connection with comets, may, in the first place, have given to us the

atmosphere of our planet, as they may possibly have since done for other planets. They render certain the existence of gaseous bodies in space, as also the possibility of different degrees of condensation of such bodies. From this, the former existence of our planet as a gaseous body is not improbable. Still further, the meteors and the meteorites generously contribute to keep up the heat and light of the sun forming, as they do, the millions of miles of cometary matter, which it is supposed, is laid quite frequently as fuel upon that central fire. But the most interesting and startling conjecture Professor Pierce publishes as the results of his investigations: "That the heat which the earth receives directly from *meteors* is the *same in amount* which it receives from the *sun* by radiation, and that the sun receives *five sixths of its heat from the meteors that fall upon it.*" This may be a fact, but as yet it is a question. However, certain interesting facts point most significantly in that direction, some of which we have already considered, as also others which we will now consider; such as the *immense number* of meteoric masses of matter, from the density of gas to rock, from the weight of a grain to a ton, and scattered every-where throughout space. The number to be seen on different occasions is extremely variable; sometimes not more than four or five during a night, while again so many appear in a small section of the sky that it is impossible to count them. An estimate of 1,000 has been made as the average daily number visible at one place to the naked eye. It is also calculated that the average distance from each other of those seen by the naked eye, under favorable circumstances, is 300 miles. Then it is found that the number visible at one place is but one thousandth part of those visible to the whole earth. Therefore the average number of meteors that traverse the atmosphere daily, and that are large enough to be seen by the unaided eye, if sun, moon, and clouds would permit, must be upward of 7,000,000. Every day our atmosphere comes in

contact with near 8,000,000 little bodies. There is collision; the meteor flashes out its sign of extinction, and, if it reaches the earth at all, it is in the form of dust or gas. But it is found that, with the telescope, upward of forty times the number visible to the naked eye are light enough to be seen. Hence, if there were no cause to prevent, about 400,000,000 would be visible from our planet, through the telescope, daily. In every space as large as that occupied by the earth and its atmosphere, there must be at least 13,000 bodies sufficiently large and luminous to be visible to the naked eye, and forty times as many which can be seen through the telescope. Dr. Schmidt claimed that in 1873 he succeeded in obtaining a telescopic view of a system of bodies which had turned into meteors. These meteors he saw as two larger bodies, followed by smaller ones, all moving in a parallel direction until utterly consumed. It is possible that, like worlds and satellites, they had been revolving about each other before coming into contact with our atmosphere. Probably our planet has many such bodies revolving around it, somewhat after the manner of the moon, but remaining invisible until drawn so near as to ignite by contact with our atmosphere. We do not know just exactly what effect this conflagration of meteors has upon our atmosphere. No doubt it produces a very considerable agitation which may extend to a very great distance; and yet, he is undoubtedly a presumptuous man who attempts to predict, with any degree of certainty, the time, locality, extent, and strength of storms of wind and rain upon the fact of a more than ordinary fall of heavy meteors. About all that can be said with safety is that meteors undoubtedly produce atmospheric disturbances; but it is probable that they are largely, if not wholly, confined to the upper regions. These disturbances may doubtless somewhat resemble whirlwinds caused by fire. An extensive fire frequently produces a strong upward motion of the air,

and of sufficient force, as known upon burning western prairies, to lift a man from the ground and carry him a considerable distance. "Some years since, during the burning of a canebrake in Alabama, several whirls were formed in the midst of the flames, some of which rose to the height of two hundred feet, and in form resembled the upper cone of an hour-glass. Similar effects were produced by the conflagration of Moscow, September 14–20, 1812."

A very significant fact in connection with a meteoric shower is that it proceeds from some center, called the radiant-point. Upward of fifty radiant-points have been discovered. The center, or radiant-point, of the August meteors is in the constellation of Perseus, while that of the November meteors is in the direction of the star Gamma, of the constellation Leo. Without doubt this point is far distant from the earth, since it seemed fixed among the stars, and, like them, apparently moved westward. If the source of meteors was within our atmosphere, this radiant-point would have revolved with it from east to west, whereas its course was in the opposite direction. The radiant-point of the November shower of 1833, instead of appearing luminous, was a dark circular space on the sky of several degrees in diameter. The meteoric lines of light all seemed to proceed from this point, although the meteors were not always seen to start from it. The inference is that at that point a huge globe of gaseous or phosphorescent matter was the source of these meteors. From *it* the superior attraction of the earth drew separate portions of its substance into our atmosphere, which set them on fire. The light from some of these burning portions differed in color, probably owing to the predominance of different elements in each. Some, indeed, exhibited a most beautiful and delicate blending of all the hues of the rainbow, as they streamed across the sky. Taken all in all, this spectacle was, however, more terrifying than pleasing to many who saw it. Perhaps while gazing upon the starry splendors of the night,

and contrasting the order, harmony, and serene constancy of the celestial bodies with the change, conflict, and confusion of earth, you are suddenly startled by, seemingly, the largest and brightest of the stars sweeping with furious speed across the sky, with a noise like that of the hurricane's roar or the rushing sound of a sweeping simoom, and thus invading the order and harmony of celestial position and motion, which is still further violated by a succeeding down-pour of star-like bodies. Sad and fearful, you turn to look for the dark void overhead, which has been emptied of its ancient glory, and you see that not a single gem has been lost from the diadem of Night. "She still moves on in the same solemn silence, her train still glittering with the same magnificent garniture of worlds. That strange light was only a transient meteor, kindled and quenched in the earth's stormy and sulphurous atmosphere. It is only the mistaken glance of the moment which has led you to transfer the disorder and ruin of this groaning habitation of man to the serene and unchanging heavens." Far beyond where the meteor flames and expires, far beyond its radiant-point, far beyond the utmost reach of solar light, the shining host of heaven still observes the same silent harmony and perfect order. Even when the contentious struggle, the agony and the death of man's brief day is over, the night, then as ever, will marshal forth God's host, with all their beacon fires still burning upon the plains of heaven.

Disobedience to God is the only discord that has ever disturbed the peace or darkened the light of the universe. Comets in ghostly light, the seemingly erratic meteors in blazing fire, shoot athwart the heavens obedient to his will. Man has kindled all the fires that burn, caused all the tempests that rage in a guilty soul, and brought misery and desolation upon our suffering world by his disobedience to God. What folly to oppose him who guides the comets in their courses, scatters meteors and meteorites at his will, and whose un-

aided hand upholds the millions of worlds! Why should we stand in the way of the fulfillment of purposes which are from everlasting and for the harmony and the happiness of millions of immortals? "To sin against God is such blindness and madness as it would be for a feeble man to lift his hand to sweep the sun from the heavens and to blot out the stars from the sky."

TEACHINGS AND GLORY OF THE HEAVENLY BODIES.

"The periodic meteors of November probably comprehend bodies having an equal range of magnitude, and perhaps also of density."—Loomis.

"God's creative power has called into existence every ray of light that shines, and every system of worlds that rolls in immensity. The breath of the Almighty has given life to the smallest insect and to the mightiest archangel."

"Science, having dazzled our vision and bewildered our minds with the infinite blaze of suns and systems of worlds, shows us millions of perfectly organized beings in a drop of water."

"One hour of silent sunshine will do more to change the face of the earth than millions of men can do in a life-time of toil. With all the united force of all thine armies, thou canst not wound the fair face of the earth so deeply as one surge of the pent-up fires that burn beneath thy feet. One tremble of the earthquake, one throb in the fiery heart of the volcano, one hour of the ocean's stormy wrath, the removal of one element from the air, the water, or the light, will do more to change the globe than all thine arts and engines in years of toil. And yet the whole earth of thy habitation is but a single mote in the star dust with which God's creative hand has strewn the skies."—Daniel March.

"How is night's sable mantle labored o'er!
How richly wrought with attributes divine!
What wisdom shines! what love! this midnight pomp,
This gorgeous arch with golden worlds inlaid,
Built with Divine ambition."—YOUNG.

"Here truths sublime and sacred science charm;
Creative arts new faculties supply;
Mechanic powers give more than giant's arm;
And piercing optics more than eagle's eye."

"*Practical Astronomy* treats of astronomical instruments and their application. These instruments are usually placed in a building called an observatory, which is erected in a suitable situation for obtaining an uninterrupted view of the heavens."—BOUVIER.

"Princes are like to heavenly bodies which cause good and evil times, and which have much veneration, but no rest."—BACON.

"I care not, Fortune, what you me deny:
You cannot rob me of free Nature's grace;
You cannot shut the windows of the sky,
Through which Aurora shows her bright'ning face."
—THOMSON.

METEORS.

[THOUGHT-OUTLINE TO HELP THE MEMORY.]

1. How comets, meteors, and meteorites differ? Some remarkable cases?
2. Theories of their origin? From sun, from stars?
3. Meteoric displays? Brilliant one of 1833?
4. Effect of meteors? Prof. Pierce's theory? Heat of sun and earth increased? Atmospheric disturbances?
5. Moral aberrations only to be feared?

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